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(54) Title: ORAL TREATMENT OF HELICOBACTER INFECTION

(57) Abstract

Method of eliciting in a mammalian host a protective immune response to *Helicobacter* infection, by orally administering to the host an immunogenically effective amount of *Helicobacter* antigen. Vaccine compositions are also provided.

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ORAL TREATMENT OF HELICOBACTER INFECTION

The present invention relates to the treatment of gastric infection in mammals, including humans. More particularly, the present invention relates to a method for the treatment of Helicobacter infection in mammals, including humans, and to vaccine compositions and antibodies suitable for use in such treatment.

BACKGROUND OF THE INVENTION

Helicobacter pylori (H. pylori) infection of human gastric epithelium is a major factor in the development of gastritis and ulcers and may be a risk factor for the development of gastric cancer[1-3]. This slender S-shaped gram negative microorganism is routinely recovered from gastric tissue of adults and children with histologic evidence of gastritis or peptic ulceration. Evidence for a causal relationship between H. pylori and gastroduodenal disease comes from studies in human volunteers, gnotobiotic pigs, and germ-free rodents whereby postulates by Koch were satisfied by creating histologically confirmed gastritis following consumption of viable microorganisms[4-11]. Although difficult to treat, when eradication is achieved the underlying gastritis resolves and, in patients with duodenal ulcer disease, the recurrence rate of the ulcer decreases dramatically[12].

In spite of in vitro susceptibility to many antimicrobial agents, in vivo long-term eradication of established H. pylori infections with

antimicrobial agents is difficult to achieve[18]. The microorganism is found within the mucous coat overlying the gastric epithelium. This is a location which does not appear to allow for adequate antimicrobial levels to be achieved when given orally. At the present time, most authorities recommend a "triple therapy", namely a bismuth salt in combination with tetracycline and metronidazole for 2-4 weeks. However, the effectiveness of this or other chemotherapeutic regimens remains suboptimal.

At the present time little is known regarding the role of the mucosal immune system in the stomach. The distribution of Ig producing cells in the normal gastric antrum indicates that IgA plasma cells make up 80% of the total plasma cell population. In addition, the number of plasma IgA cells present in the gastric antrum is comparable to other mucous membranes[25,26]. Although a number of studies have looked at immunoglobulin levels in various endocrine fluids, no data is available regarding the concentration of immunoglobulins in gastric secretions. Moreover there is only limited data to suggest that patients infected with H. pylori develop specific IgG and/or IgA antibodies in gastric aspiarates[32]. Thus, once infection is established, neither antibody nor antibiotics are very effective at eradication.

Czinn et al have shown that repetitive oral immunizations with H. pylori antigens and cholera toxin result in the inducement of a vigorous gastrointestinal IgA anti-H. pylori response in mice and ferrets[18]. However, since mice and ferrets are resistant to H. pylori infection and since no

small animal model existed at that time to evaluate protection, it was unknown whether the antibodies so formed were protective.

Lee et al have reported the ability to infect germ-free rodents with H. felis and reproducibly document histologic gastritis[9,10]. However, no evaluation of protection has been reported.

There remains a need therefore for an effective treatment of H. pylori gastric infection, especially in humans. The present invention seeks to fill that need.

SUMMARY OF THE INVENTION

The present inventors have discovered, surprisingly, that oral immunization of a host with Helicobacter antigen results in the formation of antibodies which are protective against acute infection by Helicobacter microorganisms. The formation of such protective anibodies was not predictable on the basis of prior work since, prior to the present invention, no suitable model existed to evaluate protection.

According to one aspect of the present invention, there is provided a method of eliciting in a mammalian host a protective immune response to Helicobacter infection, comprising orally administering to the host an immunogenically effective amount of Helicobacter antigen to elicit the desired protective immune response.

According to another aspect of the present invention, there is provided a vaccine composition comprising an amount of Helicobacter antigen

effective to elicit a protective human response in a patient, in association with a pharmaceutically acceptable diluent.

According to a further aspect of the present invention, there is provided a method of imparting to a mammalian host passive protection to Helicobacter infection, comprising orally administering to the host a immunologically effective amount of a Helicobacter specific IgA antibody to impart the desired passive protection.

According to yet another aspect of the present invention, there is provided a murine H. felis specific IgA or IgG monoclonal antibody.

According to a yet further aspect of the invention, there is provided a cell line #71-G_5-A_8.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be further described with reference to the accompanying figures, in which:

Figure 1 is is a bar chart of antibody titers in various sera and secretions of germ free mice after oral immunization with H. felis lysate in association with cholera toxin; and

Figures 2A and 2B are bar charts of percent of mice infected with H. felis after active immunization (Figure 2A) and passive immunization (2B) compared with controls.

DETAILED DESCRIPTION OF THE INVENTION

The present inventors have demonstated that oral

immunization in mice using H. felis antigen produces a protective immune response wherein antigen specific protective antibodies are present in gastric secretions. The effect of the protective immune response is that immunized animals when challenged with pathogen do not become infected in comparison to non-immunized animals which do become infected. While not being bound by any theory, the present inventors believe that oral immunization with the H. felis antigen stimulates the common mucosal immune system and perhaps local sites in the gastric mucosa resulting in the appearance of H. felis specific IgA antibodies in the gastric secretions, which prevent H. felis infection. Since H. felis and H. pylori are simliar species from the same genus (Helicobacter), it is reasonable to conclude that immunization of for example a germ-free pig with H. pylori antigen plus a mucosal adjuvant such as cholera toxin will be effective in preventing H. pylori infection of the stomach. Since it is a routine matter to conduct pre-clinical trials of candidate vaccines for human use in animal models, it is believed that the methodology of the present invention is effective in humans, especially in the treatment of H. pylori infection in humans.

It has been discovered by the present inventors that an H. felis germ-free mouse model can be employed to evaluate antibody protection levels following immunization with H. felis antigen. Figure 1 relates to the results obtained in experiments with the H. felis germ-free mouse model. Oral immunization of the model with bacterial antigens in association with cholera toxin resulted

in elevated serum, gastric and intestinal anti-H. felis antibody titers and protection from acute infection of the stomach by H. felis pathogen. In the experiments, groups of Swiss-Webster germ-free mice (Taconic) were orally immunized 4 or 5 times over a one month period with 2-4 mg of sonicated H. felis lysate plus 10 µg of cholera toxin. The mice were then challenged orally with approximately 10^6 viable H. felis bacteria. The mice were sacrificed and intestinal and gastric secretions collected as described in the following working Examples. Anti-H. felis antibody titers were determined by ELISA. The black solid bars in Figure 1 represent mean titers (± S.D.) from immunized mice and the open bars represent mean titers (± S.D.) from the control non-immunized mice. The results presented graphically in Figure 1 are summarized in Table 1 below.

TABLE 1

ANTIBODY TITER (LOG_2)

	Serum		Gastric		Intestine	
	IgA	IgG	IgA	IgG	IgA	IgG
CONTROL	3.1	3	0	0	1.6	1.1
IMMUNIZED	11.8	16.8	2.1	4.25	4.5	4.4

	H. FELIS INFECTION		PROTECTION
	H. felis (+)	H. felis (-)	
Control n=18	14	4	23%
Immunized n=17	4	13	78%

It can be seen from the above results that significantly higher antibody titers are observed for the immunized mice than for the control animals.

Figures 2A and 2B depict the results of studies to establish the protection against infection by H. felis by conducting active and passive immunization experiments. Referring to the active immunization experiments, gastric biopsies were collected at sacrifice from the H. felis challenged mice in the experiments described above in connection with Figure 1. The biopsies were scored for the presence of H. felis by rapid urease test and/or culture positivity, described in the following working Examples. Figure 2A shows the results of pooled data from 3 experiments (n = 17 immunized animals and 18 control animals). The black (solid) bars represent challenged immunized mice and the striped bars the control non-immunized mice.

It will be seen that from a total of 17 immunized animals, only 4 became infected, as compared to 14 of the 18 control animals. In other words, 78% percent of the immunized animals were protected from H. felis infection as compared to 23% of the non-immunized animals.

The fact that protection was the direct result of IgA antibodies was established by passive immunization of germ-free mice with H. felis specific IgA monoclonal antibodies and comparison of the resulting protection with that exhibited by mice given no antibody or irrelevant antibody (for example Sendai virus specific IgA monoclonal antibody). The results are set forth in Figure 2B.

An IgA monoclonal antibody reactive with H.

felis was isolated and subcloned after an immunization protocol similar to that described in Figure 1. Ascites containing H. felis specific IgA monoclonal antibody produced from the cell line #71-G_5-A_8, prepared as described in the working Examples, or Sendai virus specific IgA monoclonal antibody or saline were orally administered to germ-free mice at the time of infection with H. felis, and 4, 8, and 24 hours later. Seven days after infection, the mice were sacrificed and gastric biopsies scored for H. felis (n = 7 mice received H. felis specific monoclonal antibody and 13 mice received no antibody or Sendai virus specific monoclonal antibody). The black sold bars represent the mice which received the H. felis specific monoclonal antibody and the striped bars represent the mice which received either Sendai virus specific monoclonal antibody or saline (no antibody).

These results establish that IgA alone protects against H. felis infection of the gastric mucosa.

It is also observed that oral administration of H. felis antigen results in significantly increased levels of anti-H. felis IgG antibodies as well as IgA antibodies. There are a number of possible explanations for this phenomenon. First, it has been observed that cholera toxin can, in some cases, enhance both antigen-specific IgA and IgG responses[22]. Secondly, cell traffic studies have shown that mesenteric node IgG lymphocytes are a component of the mucosal immune system and can give rise to mucosal IgG plasma cells which have been observed in gastric mucosa. Thirdly, at least a portion of the observed gastric IgG could be the

result of transudation of serum antibody into the gastric lumen secondary to mild to moderate inflammation observed in both control and immunized animals.

The above discussion has focussed on the use of H. felis antigen in the treatment of H. felis infection. It will be appreciated however that the present invention is not limited to the treatment of H. felis infection.

Thus, the present invention also includes within its scope the treatment or prophylaxis of mammals, including humans, for H. pylori infection, wherein the patient is orally immunized with an immunologically effective amount of H. pylori antigen in order to elicit the formation of protective antibodies to H. pylori pathogen. Preferably, the H. pylori is administered in association with a mucosal adjuvant, for example cholera toxin.

Moreover, the present invention includes within its scope the passive immunization of mammals, including humans, against H. pylori infection. This is achieved by orally administering an effective amount of an H. pylori specific antibody to the patient. Preferably an H. pylori specific IgA monoclonal antibody is orally administered to the patient.

The vaccine of the invention is administered orally in amounts readily determined by persons of ordinary skill in this art. Thus, for adults, a suitable dosage would be in the range of 10μg to 10 mg, for example 50μg to 5 mg. Similar dosage ranges would be applicable for children.

As noted above, a suitable mucosal adjuvant is cholera toxin. Others which may be used are non-toxic derivatives of cholera toxin, including its B subunit and/or conjugates of antigen plus cholera toxin or its B subunit, microcapsules, or immune stimulating complexes (ISCOM's) or liposomes and attenuated live vectors such as viruses or Salmonella bacteria. The amount of mucosal adjuvant employed depends on the type of mucosal adjuvant used. For example, when the mucosal adjuvant is cholera toxin, it is suitably used in an amount of 5µg to 50µg, for example 10µg to 35µg. When used in the form of microcapsules, the amount used will depend on the amount employed in the matrix of the microcapsule to achieve the desired dosage. This is something within the skill of a person of ordinary skill in this art.

Suitable carriers and diluents are enteric coated capsules and/or 0.2N $NaHCO_3$ and/or saline.

EXAMPLES

The invention will now be further described by the following non-limiting examples.

(a) The Mice

The mice used in the experiments were germ-free Swiss Webster mice (8 weeks old) were obtained from Taconic (Germantown, N.Y.). The animals were housed in microisolater cages under germ-free conditions and they were allowed free access to autoclaved laboratory chows and water. With the exception of occasionally isolating diphtheroids, animals were maintained in a germ-free state throughout the immunization protocol.

(b) Bacterial Strains

Bacteria recovered from gastric biopsy specimens of a cat were identified as H. felis based on morphology, Gram stain, and the production of urease, catalase and oxidase[9]. Organisms were stored in 50% phosphate-buffered saline (PBS). 25% glycerol: 25% heated fetal calf serum at -70°C. Bacteria used in the the following examples were passaged in vitro two to three times after isolation.

(c) Bacterial Antigens

The test strain was inoculated onto Columbia agar (Difco, Detroit, MI) containing 7% horse blood and incubated microaerophilically at 37°C for 5-7 days. The organisms were harvested in PBS and the resulting suspensions were sonicated to lyse the bacteria at 40°C, cleared of cellular debris by low-speed centrifugation, and sterile filtered. These whole-cell sonicates were stored as 100µl aliquots at -70°C until needed for oral immunization of animals.

(d) Outer membranes

Outer membranes were prepared as described[19]. Briefly, bacterial suspensions were treated with 1 mg of ribonuclease and deoxyribonuclease (Sigma Chemical, St. Louis) in 0.5 M Tris-EDTA buffer (pH 7.8) at 4°C immediately prior to sonication and low-speed centrifugation as above. Bacterial envelopes were then separated from the cleared lysate by ultracentrifugation at 150,000 x g for 1 h. Outer membranes were separated from the cell envelopes by differential solubilization in sodium n-lauroylsarcosine and recovered by ultracentrifugation. The resulting pellets were

suspended in 0.05 M phosphate buffer (pH 7.0), divided into aliquots, and stored at -70°C. Protein concentration was determined by the method of Lowry et al for use in ELISA[20].

EXAMPLE 1

Mice were lightly anesthesized by i.p. injection of 1.0 mg ketamine prior to intragastric immunization. Then, whole cell sonicate preparations plus 10 µg of cholera toxin (List Biologicals, Campbell, CA) were suspended in 0.2 M $NaHCO_3$, and 0.5 ml was delivered to the stomachs of mice by intubation through polyethylene tubing attached to a hypodermic syringe. This procedure will be referred to as oral immunization.

To examine the possibility of developing functional immunity, three oral immunization protocols were evaluated. Protocol 1 consisted of 4 oral immunizations over 1 month consisting of 2 mg H. felis lysate plus cholera toxin (a known mucosal adjuvant). Protocol 2 increased the H. felis to 4 mg per immunization plus cholera toxin, and protocol 3 consisted of 5 oral immunizations over 6 weeks each containing 4 mg of H. felis lysate plus cholera toxin. Unless otherwise noted, animals were challenged 7-10 days after the last immunization and sacrificed 3-7 days later.

The following tissue fluids were collected: serum, gastric secretions, and intestinal secretions. These samples were then titrated for the presence of anti-H. pylori antibodies by enzyme-linked immunosorbent assay (ELISA). In addition, gastric biopsies were obtained for rapid urease test and culture. Infection was defined as positive if either

culture or rapid urease test (see below) was positive. Serum was obtained by tail vein bleeding and letting the blood clot at room temperature. Gastric and intestinal secretions were collected by a modification of the procedure of Elson et al[21,22]. Briefly, gastric and intestinal secretions from mice were collected separately. Stomachs and intestines were removed and injected with 2.0 ml of a polyethylene glycol-based lavage plus anti-protease solution. The gastric lavage contained Tris buffer to neutralize gastic acid.

The ELISA was carried out as follows. Murine samples were assayed for H. felis antibodies as follows. Ninety-six well polystyrene microtiter plates were coated with 100 µl/well of appropriate outer membrane proteins (20 µg/ml) overnight at 4°C. Non-specific binding sites were blocked with 1% BSA in PBS for 90 minutes at room temperature and then the plates were washed with 0.1% BSA in PBS. Samples were tested in duplicate at dilutions ranging from neat to 1:512,000 and 100 µl of each dilution per well was added to the antigen-coated plates. Following incubation at room temperature for 90 minutes, the plates were washed three times with 0.1% BSA in PBS, and 100 µl of a 1:1000 dilution of goat anti-mouse IgA or IgG alkaline phosphatase conjugate (Zymed, San Francisco, CA) was added to each well for 90 minutes. After washing, the plates were developed with 100 µl per well of a 1 mg/ml solution of p-nitrophenyl phosphate in glycine buffer (pH 9.6) for 1 hour. The absorbance at 410 nm was measured in each well using a Dynatech MR 700 Microtiter Plate Reader. The antibody titer was defined as the

reciprocal of the highest dilution yielding an optical density of 0.05 above wells which contained antigen and which were incubated with the antibody conjugate but without the primary antibody sample[18].

The rapid urease test was carried out as follows. Two gastric biopsy specimens of 10 mg wet weight from each mouse were immediately placed in 0.2 mL Stuart urease test broth[28] and incubated at room temperature. The presence of urease was determined by color change from yellow to pink in the test broth after 4 hours[24].

Cultures were obtained as follows. Gastric antral biopsies were homogenized and plated onto Columbia agar containing 5% sheep blood, and incubated at 37°C under microaerophilic conditions (gas generating kit; Oxoid Ltd., London, UK). A positive culture was defined as visible growth after 5 days. All isolates were identified as H. felis based on morphology, gram stain and the production of urease, catalase and oxidase.

Despite minor changes in experimental design among the three groups, no appreciable differences in immune response were noted. Thus, the data were pooled and the geometric means of gastric lavage, intestinal lavage, and serum antibody titers from the 13 control and 12 immunized animals studied are set forth in Table 1 and Figure 1 discussed above.

Although these animals were both immunized and challenged, the antibody titers did not differ significantly from mice which were immunized and not challenged. In these experiments, gastric, intestinal and serum IgA and IgG antibody titers were significantly higher than that observed in the

unimmunized control animals. Specifically, there was a 4-fold increase in gastric IgA (p=.001), an 8-fold increase in intestinal IgA (p=.0038) and a 350-fold increase in serum IgA (p=.0001) compared with unimmunized control animals. Similarly, a significant elevation of gastric IgG (p=.0009), intestinal IgG (p=.0001), and serum IgG (p=.0001) was observed.

To evaluate protection from H. felis infection, gastric biopsies were taken from all animals at sacrifice and evaluated by both rapid urease test and culture, as described above. In addition, to determine whether control animals developed a chronic infection and whether immunized animals were definitely H. felis negative, additional immunized and control animals were challenged as above but were not sacrificed until 4 weeks after challenge. The rate of protection among all immunized groups of animals was not appreciably different.

In order to not exclude possible low-level infection, scoring of the gastric biopsy specimens as positive or negative for H. felis growth was not done until 5 days after plating. From plating serial dilutions of known numbers (by hemacytometer count) of culture grown H. felis, it was observed that the sensitivity of this endpoint is approximately 10 organisms. In later experiments, biopsy culture plates were sometimes kept even longer than 5 days and when plates which remained negative for visible growth were scraped and examined by wet mount, an isolated spiral shaped organism could occasionally be seen. The identity of these isolated organisms could not be confirmed, and it could not be determined if

they were viable. In any case, based on the culture results for serially diluted H. felis, it is believed that biopsy speciments which remained negative for visible growth at 5 days contained 10 or fewer bacteria.

EXAMPLE 2

IgA and IgA monoclonal antibodies specific for H. felis were produced by a modification of the procedure of Mazanec et al[15]. BALB/c mice obtained from the Jackson Laboratory (Bar Harbor, Maine) were immunized intragastrically four times over a 6-week period, the first three times with 2 mg of sonicated H. felis plus 10 µg of cholera toxin (Sigma Chemical Co., St. Louis, MO). For the last immunization, cholera toxin was omitted, and the mice also received an intravenous boost with 2 mg of H. felis protein. Three days later, the mice were sacrificed, and their spleen cells were hybridized to SP2/0 myeloma cells. Clones, obtained by limiting dilution, were screened for secretion of anti-H. felis IgA antibody by an enzyme-linked immunosorbent assay (ELISA). The resulting cell line, identified as #71-G_5-A_8, was found to be a stable IgA secreting hybridoma. After multiple subclonings, stable IgA and IgG secretors were injected intraperitoneally into pristane-primed BALB/c mice, and the ascitic fluid was harvested and clarified.

The cell line #71-G_5-A_8, as of April 13, 1992, is deposited in and maintained in viable condition in the Laboratory of Steven J. Czinn, M.D., Rainbow Babies and Children's Hospital, Room 465, Case Western University, 2074 Abington Road, Cleveland, Ohio, U.S.A. 44106. Access to the deposit

will be available to a person determined by the U.S. Commissioner of Patents and Trademarks to be entitled thereto during pendency of the present application, and all restrictions on availability of the deposit to the public will be irrevocably removed upon grant of a patent on the application.

The cell line #71-G_5-A_8 is being deposited in the American Type Culture Collection, located at 12301 Parklawn Drive, Rockville, Maryland 20852, U.S.A., under the identification number #71-G_5-A_8. The ATCC accession number and deposit date are , respectively.

EXAMPLE 3

Passive immunization studies were carried out as follows. Ascites containing IgA monoclonal antibody produced from #71-G_5-A_8 (200µl) was administered intragastrically simultaneously with 10^6 viable organisms. Preliminary studies indicated that gastric IgA titers of animals which received a single 200 µl dose of monoclonal IgA antibody declined to levels below that seen in actively immunized animals by 8 hours. Therefore, three additional doses of MAb were given over the next 24 hours. Control animals were challenged identically but received either saline or Sendai virus specific IgA monoclonal antibody (an irrelevant IgA monoclonal antibody). One week later, the mice were sacrificed. Gastric tissue was inoculated on Columbia blood agar plates and incubated for 5 days at 37°C. Infection was defined as a positive culture or a positive Stuart's rapid urease broth test.

To investigate whether IgA antibodies, the hallmark of the mucosal immune system, could by

themselves protect against H. felis infection of the gastric mucosa, H. felis IgA monoclonal antibodies were generated as described above. One of these antibodies (#71-G_5-A_8) was then passively orally administered to germ-free mice at the time of and after challenge with H. felis. Control animals received either saline or Sendai virus specific IgA monoclonal antibody specific for the hemagglutinin-neuraminidase glycoprotein of Sendai virus[16].

The results are presented in Table 2.

TABLE 2

Evaluation of Passive Administration of Antibody To Germ-Free Mice Before and After Challenge with H. felis

Antibody Administered	Number of of mice	Per Cent Infected
None-Control	7	57%
Irrelevant IgA Monoclonal	6	83%
IgA anti-H. felis monoclonal	7	14%

H. felis or Sendai virus specific IgA monoclonal antibody were given intragastrically 4 times over 24 hours concurrent with challenge with 10^6 viable H. felis. Gastric biopsies were obtained 1 week after challenge and infection was determined by culture and/or rapid urease test.

Of the 13 control animals receiving no antibody or Sendai virus antibody, 70% were infected (Figure

2B). Of the seven experimental animals, six were protected and only 1 (14%) was infected. By Chi Square analysis, the difference was significant (p=.019).

Comparison of antibody titers among experimental groups was evaluated by analysis of variance and Fisher's protected T test. For protection, absence or presence of experimental infection among groups were evaluated by Chi Square analysis.

REFERENCES

1. Blaser, M.J. "Gastric Campylobacter-like organisms, gastritis and peptic ulcer disease" Gastroenterology 1987, 93, 371-183.

2. Graham, D.Y. "Camplyobacter pylori and peptic ulcer disease" Gastroenterology 1989, 96, 615-625.

3. Parsonnet, J., Vandersteen, D., Goates, J., Silbey, R.K., Pritkink, J. and Chang, Y. "Helicobacter pylori infection in intestinal and diffuse-type gastric adenocarcinomas" J. Natl. Cancer Inst. 1991, 93, 640-643.

4. Marshall B.J., Armstrong, J.A. and McGschie, D.B., "Attempt to fulfill Koch's postulate for pyloric Campylobacter" Med. J. Aust. 1985, 142, 436-439.

5. Morris, A. and Nicholson, H. "Ingestion of Campylobacter pyloridis causes gastritis and raised fasting gastric pH" Am. J. Gastroenterol. 1987, 82, 192-199.

6. Engstrand, L., Gustavsson, S., Jörgensen, A., Schwann, A., and Schaynius, A. "Inoculation of barrier-born pigs with Helicobacter pylori: a useful animal model for gastritis type B." Infect. Immun. 1990, 53, 1763-1768.

7. Fox, J.G., Cabot, E.B., Taylor, N.S. and Laraway, R. "Gastric colonization by campylobacter pylori subsp. mustelae in ferrets" Infect. Immun. 1988, 56, 2994-2996.

8. Fox, J.G., Pelayo, C., Taylor, N.S., Lee, A., Otto, G., Murphy, C. and Rose, R. "Helicobacter mustelae-associated gastritis in ferrets: an animal

model of Helicobacter pylori gastritis in humans" Gastroenterology 1990, 99, 352-361.

9. Lee, A., Fox, J.G., Otto, G. and Murphy J. "A small animal model of human Helicobacter pylori active chronic gastritis" Gastroenterology 1990, 99, 1315-1323.

10. Fox, J.G., Lee, A., Otto, G., Taylor, N.S. and Murphy J.C. "Helicobacter felis gastritis in gnotobiotic rats: an animal model of helicobacter pylori gastritis" Infect. Immun. 1991, 59, 785-791.

11. Eaton, K.A., Morgan, D.R. and Krakowka, S. "Campylobacter pylori virulence factors in Gnotobiotic piglets" Infect. Immun. 1989, 57, 1119-1125.

12. Peterson, W.L. "Helicobacter pylori and peptic ulcer disease" N. Engl. J. Med. 1991, 324, 1043-1048.

13. Rauws, E.A.J., Langenberg, W., Houthoff, H.J., Zenon, H.C. and Tytgat, G.N.C. "Campylobacter pyloridis-associated chronic antral gastritis. A prospective study of its prevalence and the effects of antibacterial and antiulcer treatment" Gastroenterology 1988, 94, 33-40.

14. Fubara, E.S. and Freter, H. "Protection against enteric infection by secretory IgA antibodies" J. Immunol. 1973, 111, 395-403.

15. Offit, P.A. and Clark, H.F. "Protection against rotavirus-induced gastroenteritis in a murine model by passively acquired gastrointestinal but not circulating antibodies" J. Virol. 1985, 54, 58-64.

16. Mazanec, M.B., Nedrud, J.G. and Lamm, M.E. "Immunoglobulin A monoclonal antibodies protect against Sendai virus" J. Virol. 1987, 61, 2624-2626.

17. Winner, L.I., Mack, J., Weltzin, R., McKalanos, J.J., Kraehenbuhl, J.P. and Neutra, M.R., "New model for analysis of mucosal immunity: Intestinal secretion of specific monoclonal immunoglobulin A from hybridoma tumors protect against Vibrio cholerae infection" Infect. Immun. 1991, 59, 977-982.

18. Czinn, S.J. and Nedrud, J.G. "Oral Immunization against Helicobacter pylori" Infect. Immun. 1991, 59, 2359-2363.

19. Sawai, T., Hiruma, R., Kawana, N., Kaneko, M. Taniyasu, F. and Inami, A. "Outer membrane permeation of beta-lactam antibodies in Eschericia coli, Proteus mirabilis and Enterobacter cloacae Antimicrob. Agents." Chemother, 1982, 22, 585-592.

20. Lowry, O.H., Rosebrough, N.J., Farr, A.J. and Randall, R.J. "Protein measurement with the folin phenol reagent" J. Biol. Chem. 1951, 193, 265-275.

21. Elson, C.O., Ealding, W. and Lefkowitz, J. "A lavage technique allowing repeated measurement of IgA antibody in mouse intestinal secretions" J. Immunol. Meth. 1984, 67, 101-108.

22. Nedrud, J.G., Liang, S., Hague, N. and Lamm, M.E. "Combined oral/nasal immunization protect mice from Sendai virus infection" J. Immunol. 1987, 139, 3484-3492.

23. Stuart, C., Van Stratum, E. and Rustigan, R. "Further studies on urease production by Proteus and related organisms" J. Bacteriol. 1945, 49, 437-444.

24. Czinn, S.J. and Carr, H. "Rapid diagnosis of Campylobacter pyloridis-associated gastritis, J. Pediatr. 1987, 110-569-570.

25. Brandtzaeg, P. "Role of H chain and

secretory component in receptor-mediated glandular and hepatic transport of immunoglobulins in man" Scan. J. Immunol. 1985, 22, 111-146.

26. Brandtzaeg, P., Bjerka, K., KEtt, K., Kvale, D., Rognum, T.O., Scott, H., Sollid, L.M. and Valnes, K. "Production and secretion of immunoglobulins in the gastrointestinal tract" Ann. Allergy 1987, 59, 21-39.

27. McDermott, M.R. and Bienenstock, J. "Evidence for a common mucosal immunologic system" I. migration of B. immunoblasts into intestinal, respiratory and genital tissues" J. Immunol. 1979, 122, 1892-1897.

28. Mestecky, J. "The common mucosal immune system and current strategies for induction of immune responses in external secretions" J. Clin. Immunol. 1987, 7, 265-276.

29. McGhee, J.R., Mestecky, J., Dertzbaugh, M.T., Eldridge, J.H., Hirasawa, M. and Kiyono, H. "The mucosal immune system from fundamental concepts to vaccine development" Vaccine 1992, 10, 75-88.

30. Holmgren, J., Clemens, J., Sack, D.A. and Svennerholm, A.M. "New cholera vaccines" Vaccines 1989, 7, 94-96.

31. Ogra, P.L., Karzon, D.T., Righthand, F. and Macgillivray, M. "Immunoglobulin response in serum and secretions after immunization with live and inactivated poliovaccine and natural infection" N. Engl. J. Med. 1968, 279, 895-900.

32. Wyatt, J.I., Rathbone, R.J. and Heatley, R.V. "Local immune response to gastritic campylobacter in non-ulcer dyspepsis" J. Clin. Path. 1986, 39, 863-870.

33. Kazi, J.I., Sinniah, R., Jaffrey, N.A., Alam S.M., Zaman, V., Zuberi, S.J. and Kazi, A.M. "Cellular and humoral immune response in campylobacter pylori-associated chronic gastritis" J. Pathol. 1989, 159, 231-237.

WHAT IS CLAIMED IS:

1. A method of eliciting in a mammalian host a protective immune response to Helicobacter infection, comprising orally administering to the host an immunogenically effective amount of Helicobacter antigen to elicit said protective human response.

2. A method according to claim 1, wherein said Helicobacter antigen is H. pylori antigen.

3. A method according to claim 1, wherein said Helicobacter antigen is H. felis antigen.

4. A method according to claim 1, wherein said Helicobacter antigen is administered in association with a mucosal adjuvant.

5. A method according to claim 4, wherein said mucosal adjuvant is cholera toxin.

6. A method according to claim 1, wherein said mammalian host is human.

7. A vaccine composition suitable for the treatment of Helicobacter infection, comprising an immunogenically effective amount of Helicobacter antigen for eliciting a protective immune response in a mammalian host, in association with a pharmaceutically acceptable carrier or diluent.

8. A vaccine composition according to claim 7, and further comprising an effective amount of a mucosal adjuvant.

9. A vaccine composition according to claim 8, wherein said mucosal adjuvant is cholera toxin.

10. A vaccine according to claim 7, wherein said Helicobacter antigen is H. pylori antigen.

11. A vaccine according to claim 7, wherein said Helicobacter antigen is H. felis antigen.

12. A method of imparting to a mammalian host passive protection to Helicobacter infection, comprising orally administering to said host a immunologically effective amount of a Helicobacter specific IgA antibody to impart said passive protection to said host.

13. A method according to claim 12, wherein said antibody is a murine H. felis specific IgA antibody.

14. A method according to claim 13, wherein said antibody is a murine H. felis specific IgA monoclonal antibody produced by cell line #71-G_5-A_8.

15. A method according to claim 12, wherein said mammalian host is human.

16. A murine H. felis specific IgA monoclonal antibody.

17. A murine H. felis specific IgA monoclonal antibody.

18. The cell line #71-G_5-A_8.

19. A monoclonal antibody produced by cell line #71-G_5-A_8.

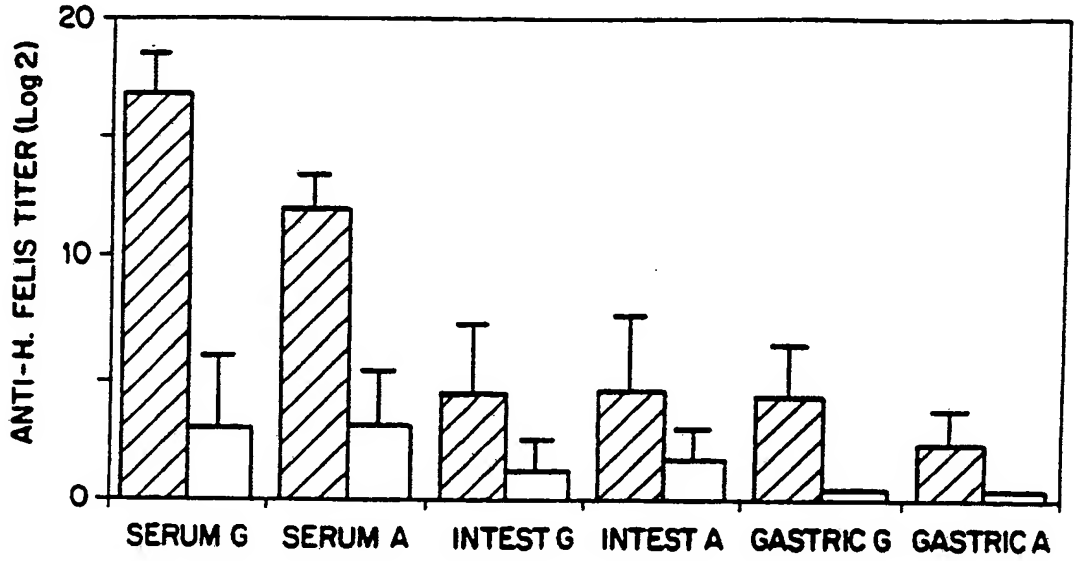

FIG. 1

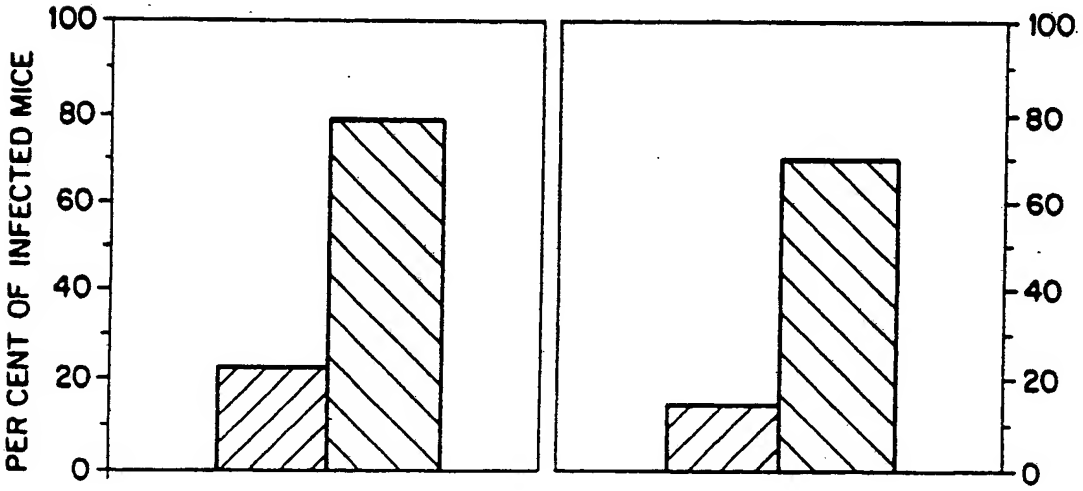

FIG. 2A

FIG. 2B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US93/03409

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) :A61K 39/02, 35/14; C07K 3/00, 13/00, 15/00, 17/00
US CL :424/85.8; 530/388.2, 388.4

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 424/85.8; 530/388.2, 388.4

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS and Medline
search terms: Helicobactor (pylori or felis)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Scand J. Infect Dis, Vol 22, issued 1990, Lelwala et al. "Detection of antibodies to Helicobacter pylori cell surface antigens.", pages 457-465, see entire document.	1-19
Y	Arch Intern Med, Vol 150, issued May 1990, Chamberlain, et al. "Campylobacter (Helicobacter) pylori Is peptic disease a bacterial infection", pages 951-955, see entire document.	1-19

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be part of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 May 1993	06 JUL 1993
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	Authorized officer DONALD E. ADAMS, PH.D.
Facsimile No. NOT APPLICABLE	Telephone No. (703) 308-0196

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US93/03409

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Infection and Immunity, Vol 59, No. 3, issued March 1991, Fox et al. "Helicobacter felis gastritis in gnotobiotic rats: an animal model of Helicobacter pylori gastritis", pages 785-791, see entire document.	1-19